Remote control for cupboards and drawers in the kitchen with arm movement detection

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Subject Code: INFO90003
Subject Name: Design Novel Interaction

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1 Introduction

This project is a work-like prototype for a draw remote control system based on arm movement detection.

The displayed work does not contain all designed function due to cost limit, time limit and technical limit.

The software of this project is coded by Arduino.

How to use
The operation is very simple, the only thing users need to do is to rotate their arm and put their arms up and down

The detailed user flow would be displayed in diagram.

3 Problem statement

1. Stakeholder:

All possible kitchen drawer users. e.g. students, office workers, cooks

2. How they use the drawers:

Through background research, drawers and cupboards are frequently used in kitchen scenario. Every time the users need a plate or ingredient from a container like drawer, cupboard or a fridge, they need to walk to the container, open the container and take the thing out, then close the container.

3. Limitations

May be a long way to go
Do not know which drawer is the item located
The kitchen layout may make the action of opening a drawer uncomfortable

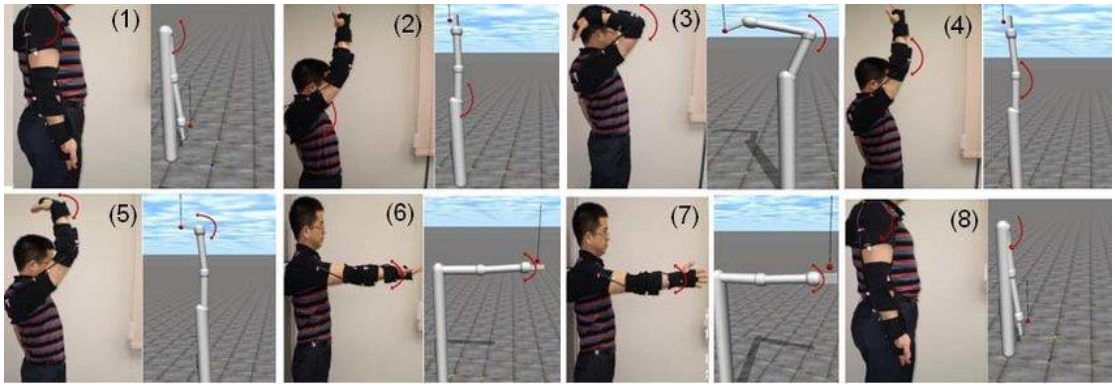
4. Problem statement:

What if we build a drawer that can be open remotely and is not controlled by a common remote control?

5. How it would improve the situation

The idea for the design is to save time by integrating time of walk to the drawer and open the drawer together, even there could be another system that can help users to take the thing out after the drawer is open, then the only thing the users need to do is open the drawer or cupboard remotely by gesture and wait.

2 Background research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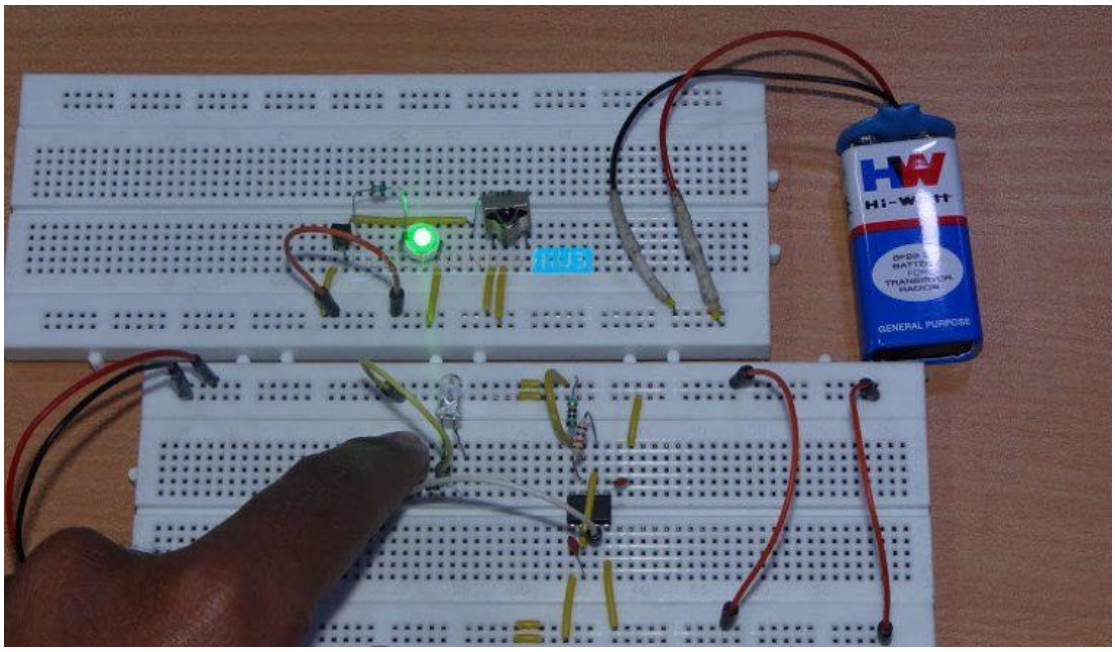
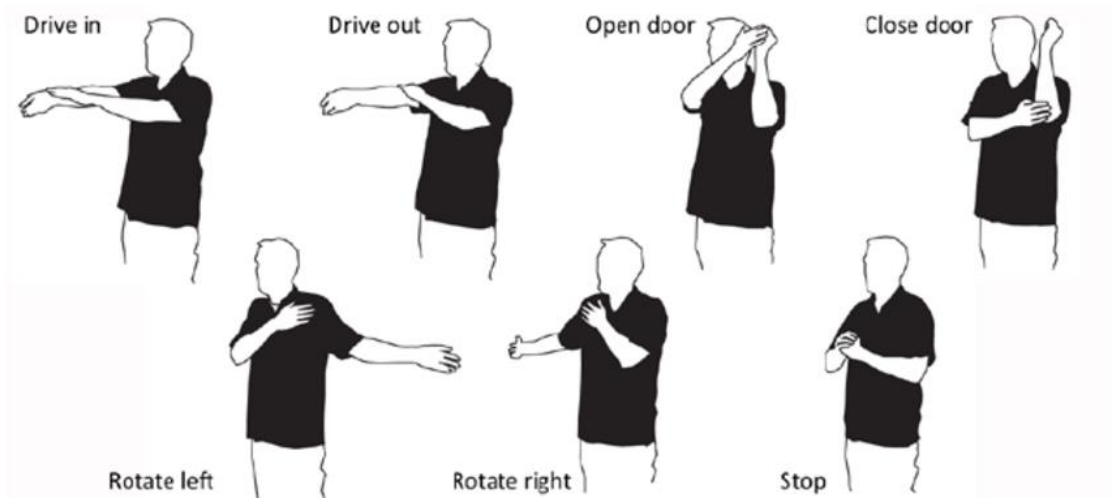
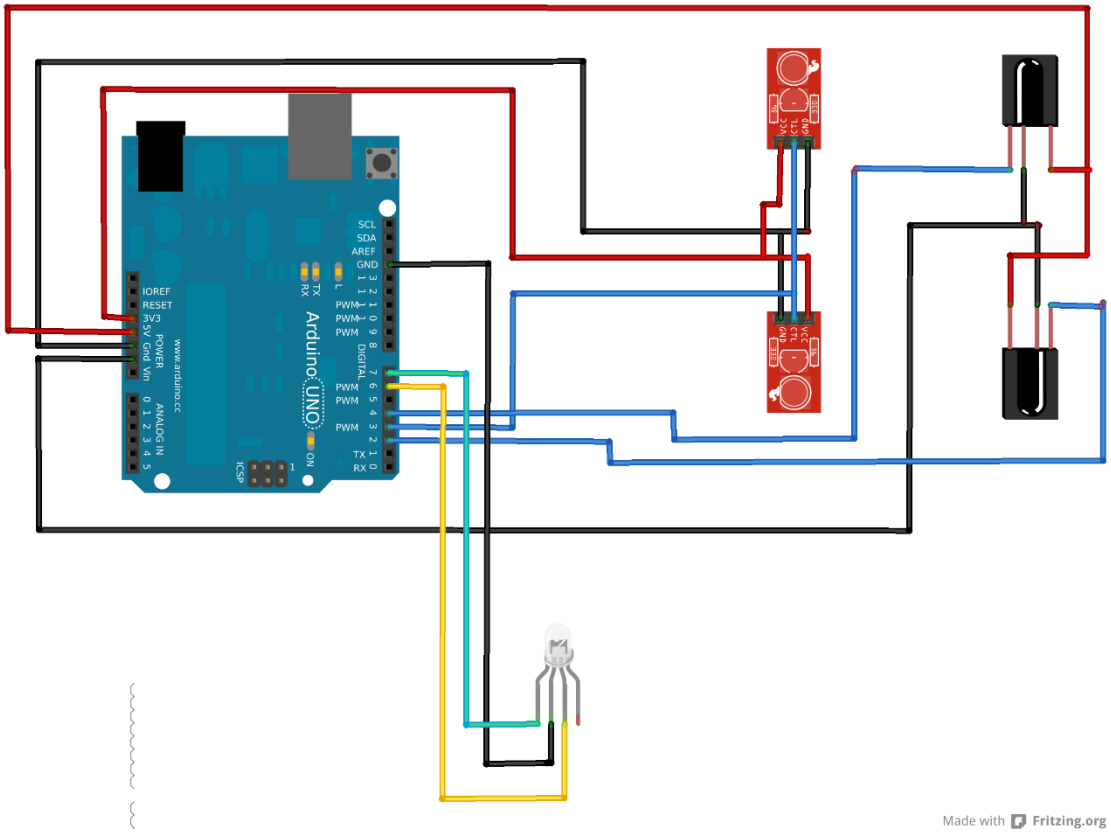
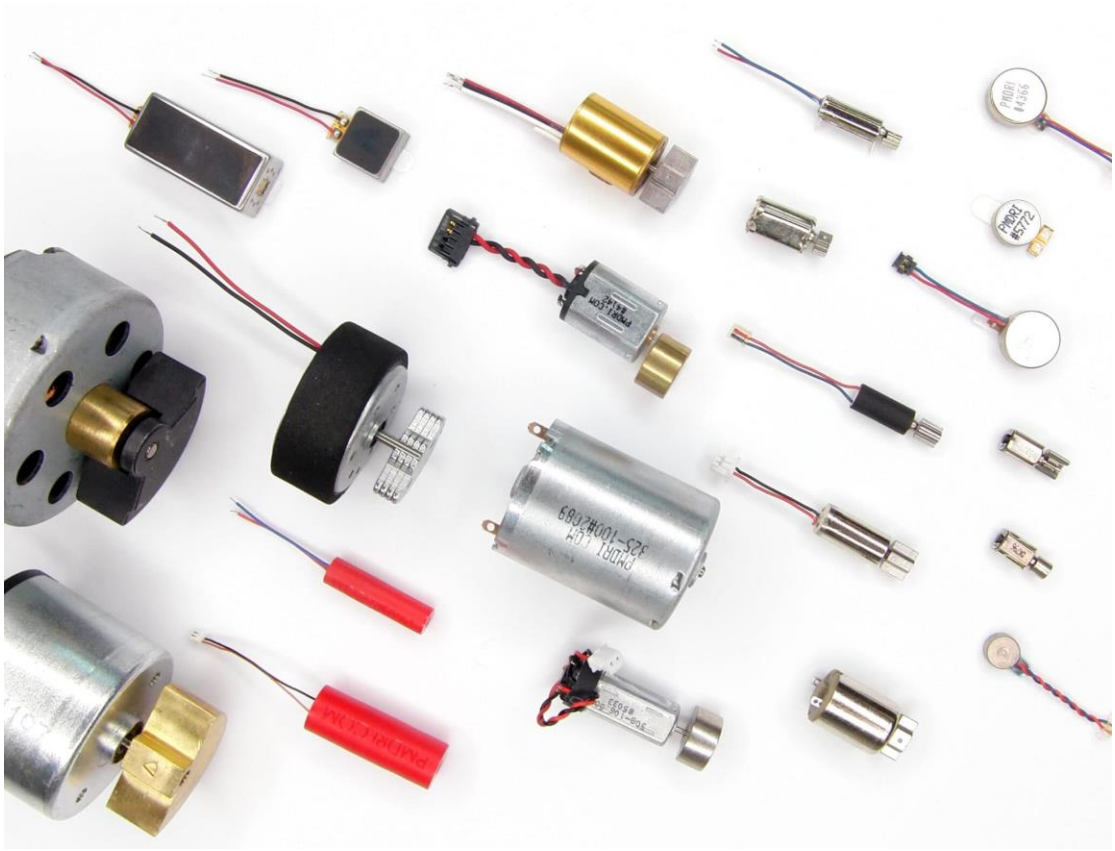
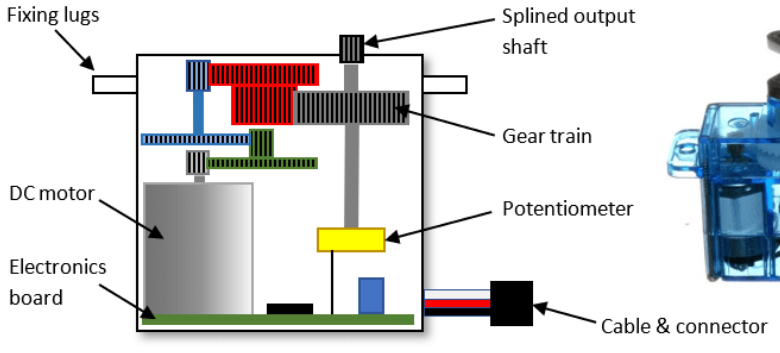

HW
GENERAL PURPOSE


Drive in
Drive out
Open door
Close door
Rotate left
Rotate right
Stop


SCL
SDA
AREF
GND
IOREF
RESET
3V3
5V
Gnd
Vin
POWER
ANALOG IN
Arduino UNO
DIGITAL
PWM
TX
RX
ICSP
ON
www.arduino.cc
Made with Fritzing.org


POLICE



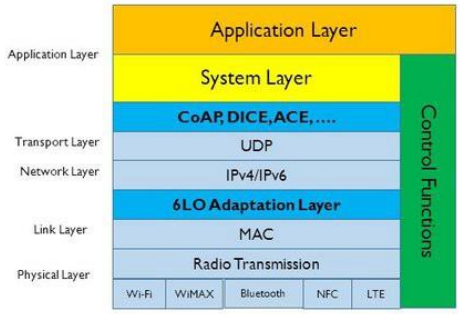


Servo Connections	
Signal	**Wire Colour**
Control	White or Yellow
+V	Red
Gnd	Black or Brown

No internal support structure shown.
Total gear ratio is about 180:1. Note 'heavier' gears driving the output shaft.

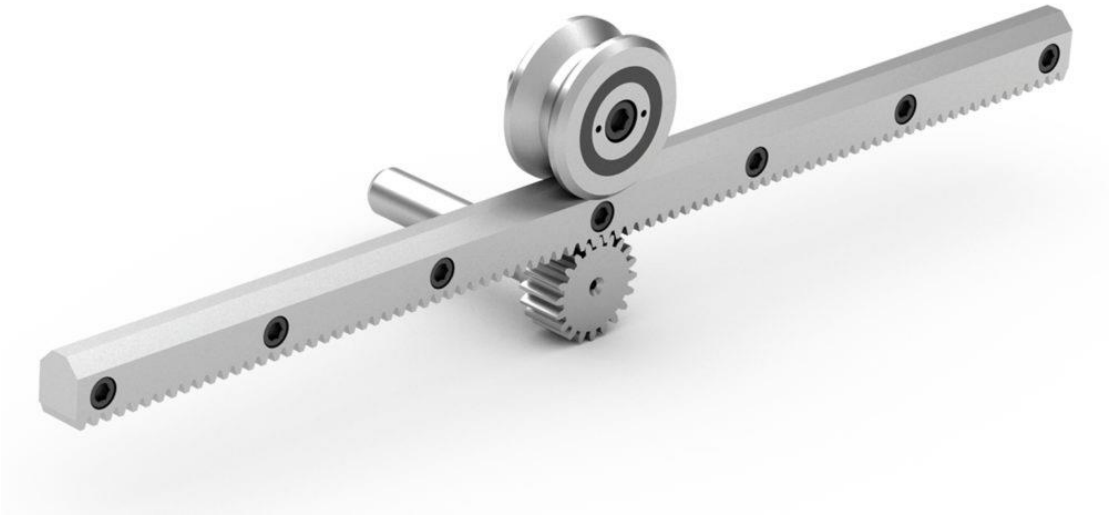
Fig.1 Inside a Servo

Variety of IoT Protocols



- Various Physical Layers
  - WiFi, WiMAX, BLE, NFC, LTE, …
- Various 6LO Functions
  - IPv6-over-foo adaptation layer using 6LoWPAN technologies (RFC4944, RFC6282, RFC6775 ..)
- Constrained Application Protocol
  - RFC 7252 CoAP and related mapping protocols
- Constrained Security Protocols
  - DTLS In Constrained Environments (DICE, draft-ietf-dice-profile-05)
  - Authentication and Authorization for Constrained Environments (ACE, Work-in-Progress)

Note that we will mainly focus on end-to-end networking to resource-constrained nodes using 6LO, CoAP, DICE, RIOT protocols, etc.




BARCO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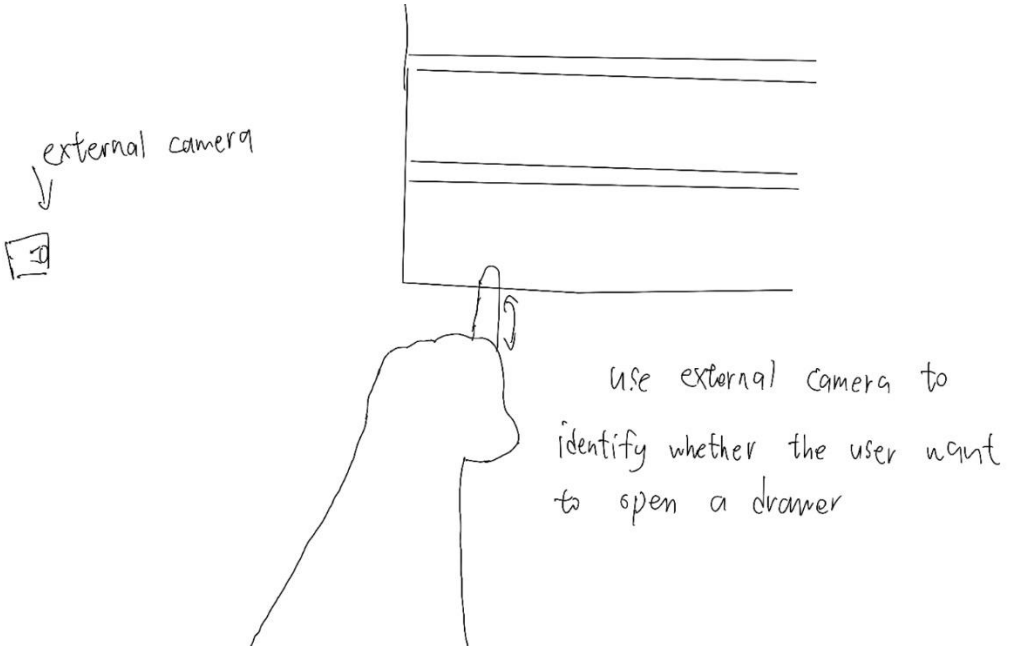
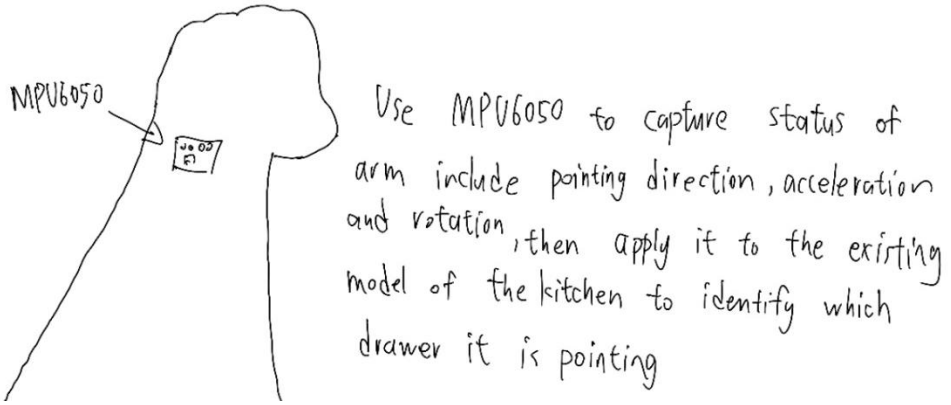
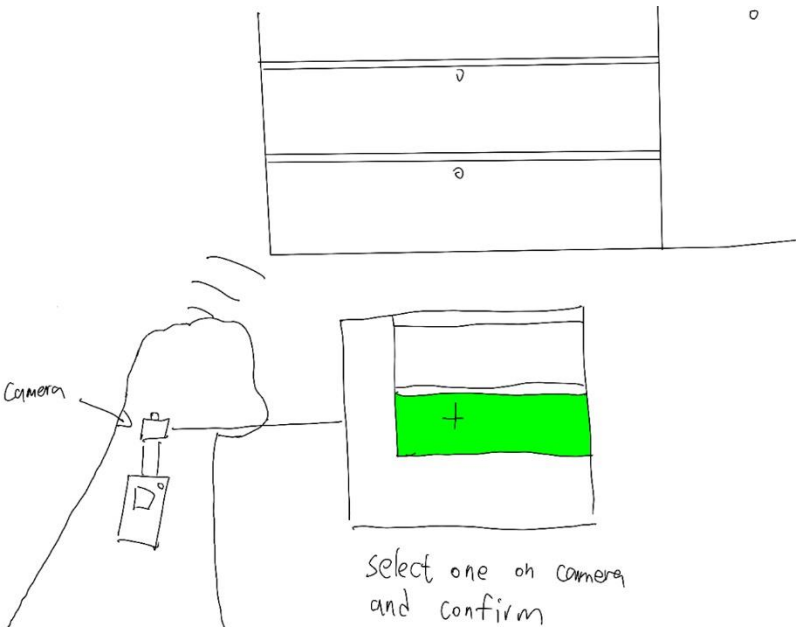
[ESP32 Web Server with MPU-6050 Accelerometer and Gyroscope (3D object representation) - YouTube]

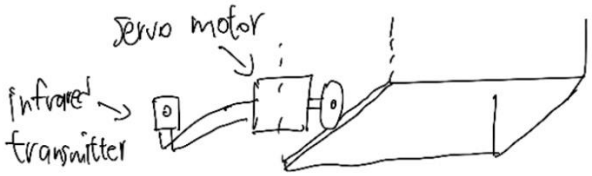
4 Summary of your ideation process

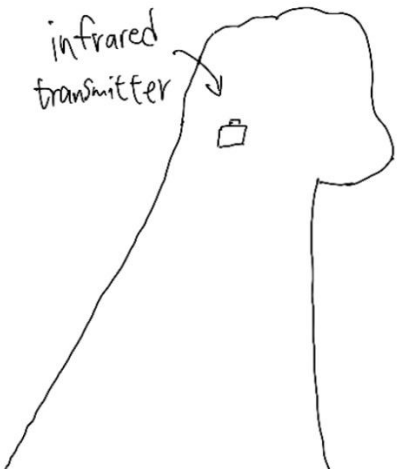
After the problem statement is done, I tried to find inspiration from internet and lectures. It turns out that using camera to identify users' commands is an expensive and bulky solution, the project is going to find out a solution that can understand users' intention accurately with acceptable cost, it seems that MPU6050 is an excellent device for a simple project to capture the status of an object, then I decided to use it to identify users' arm movement with a infrared system to seek the drawer a user wants to open.



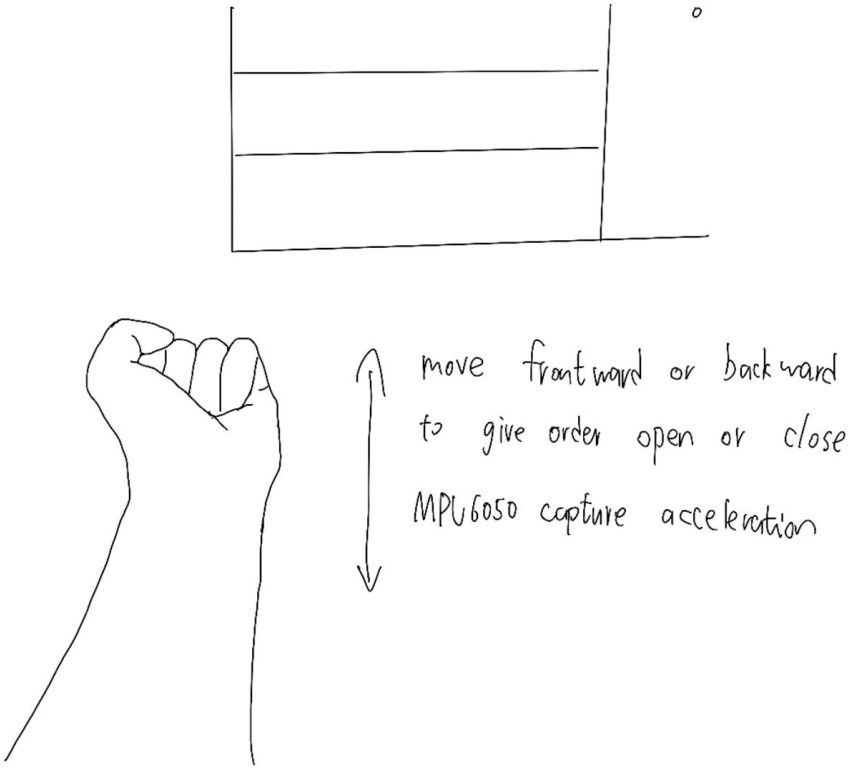


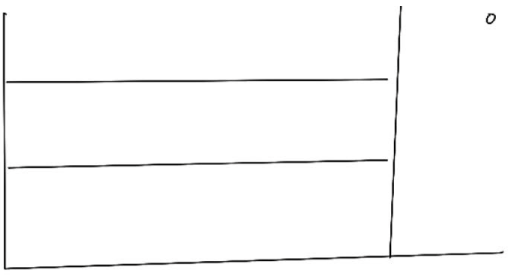

Camera
select one on camera
and confirm

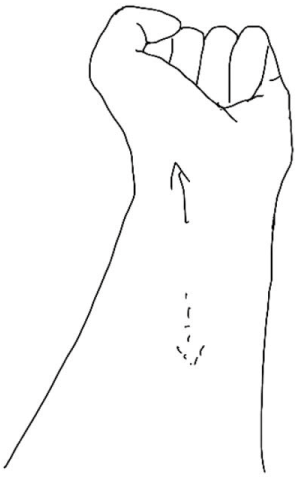

Servo motor
infrared
transmitter


infrared
transmitter

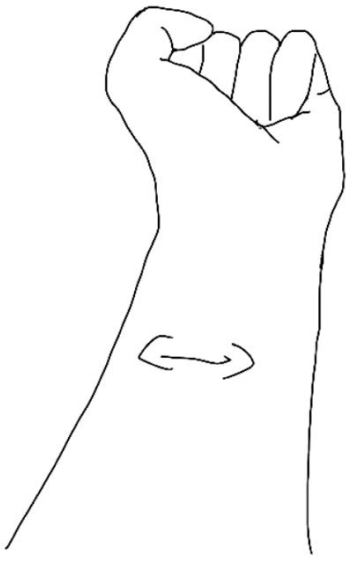
Then, the question comes to how to control the drawers, the initial idea is to let users simulate the action when they are open a drawer or a fridge. Although the idea is achievable, the solution needs a lot of study on machine learning models to reduce the noise from data or identify where the user is giving the command so that the system can understand users' actions appropriately. Thus, I decide to let users control the drawer by lift up and put down their arm, this design saves a lot of resource for the project and make the operation more learnable.



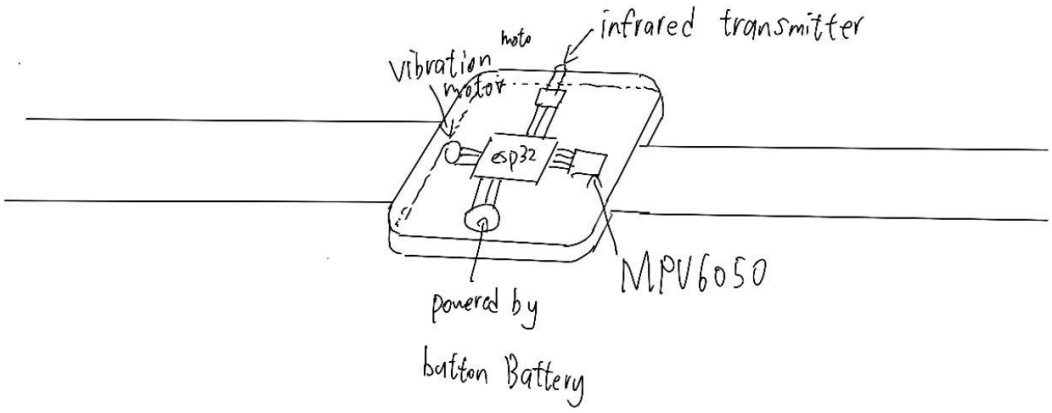




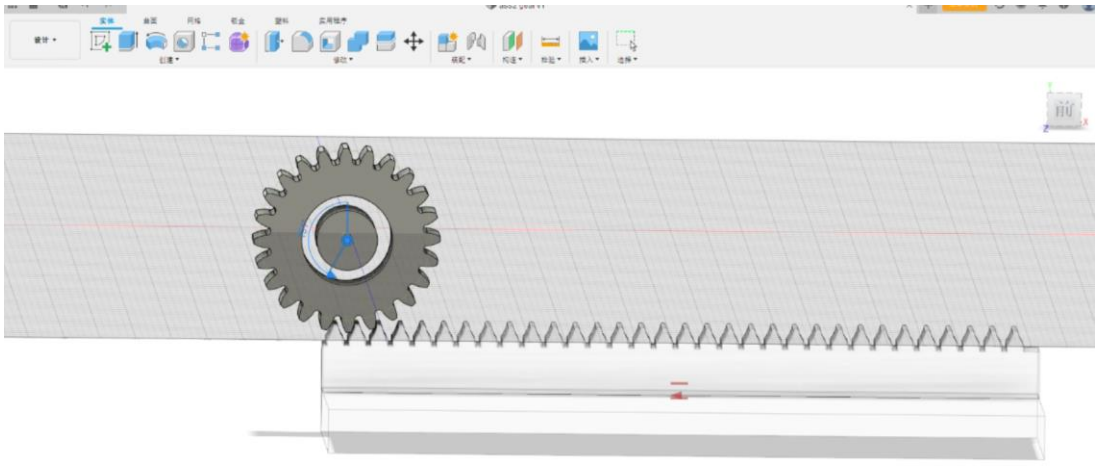
move up or down
to give order open or close
MPU6050 capture degree of
movement



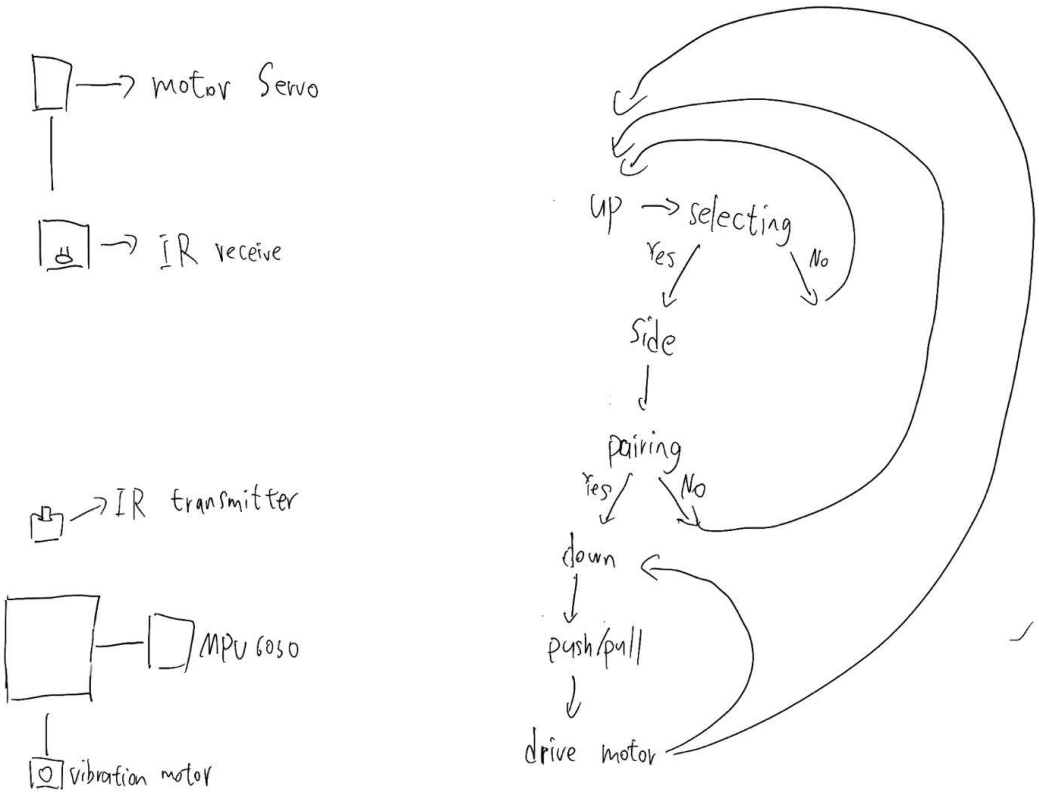
move left or right
to give order open or close
MPU6050 capture acceleration



The transimitter system should be integrated in a watch size device

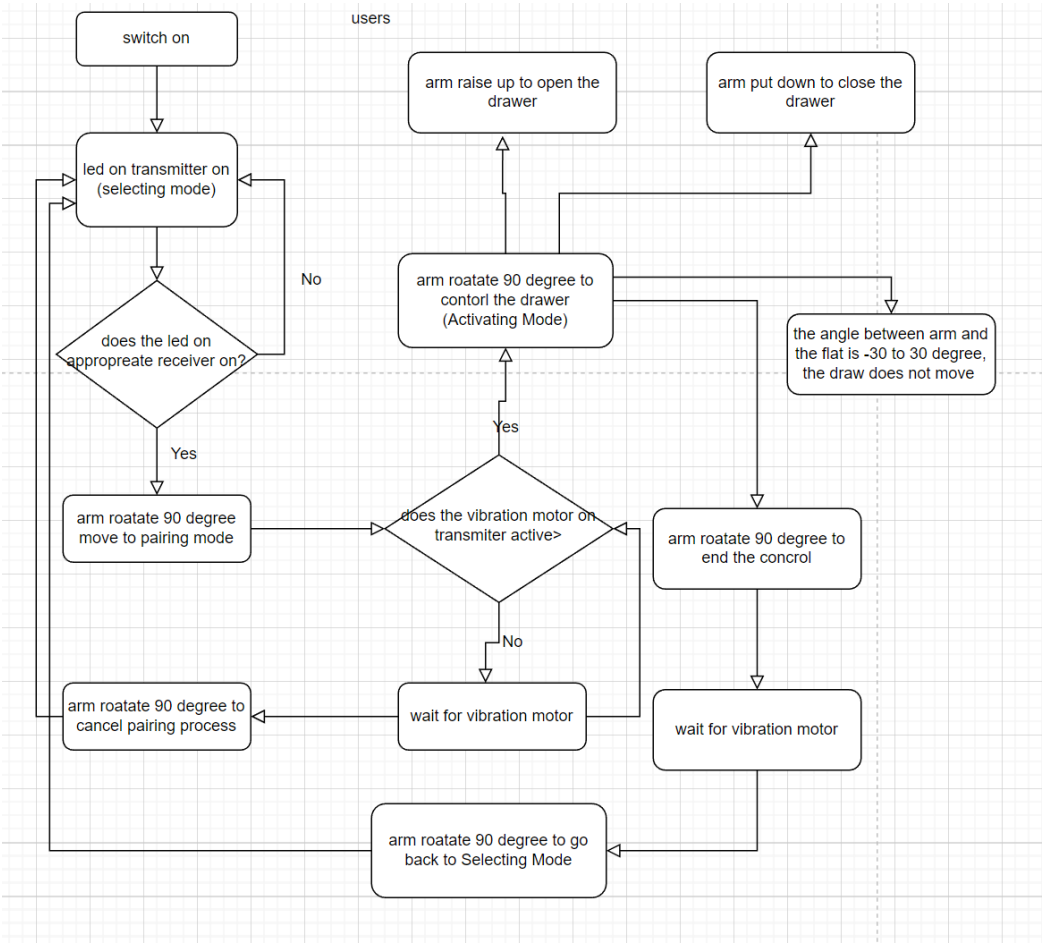


Mechanical transmission between drawer and motor (motion linked by gear)

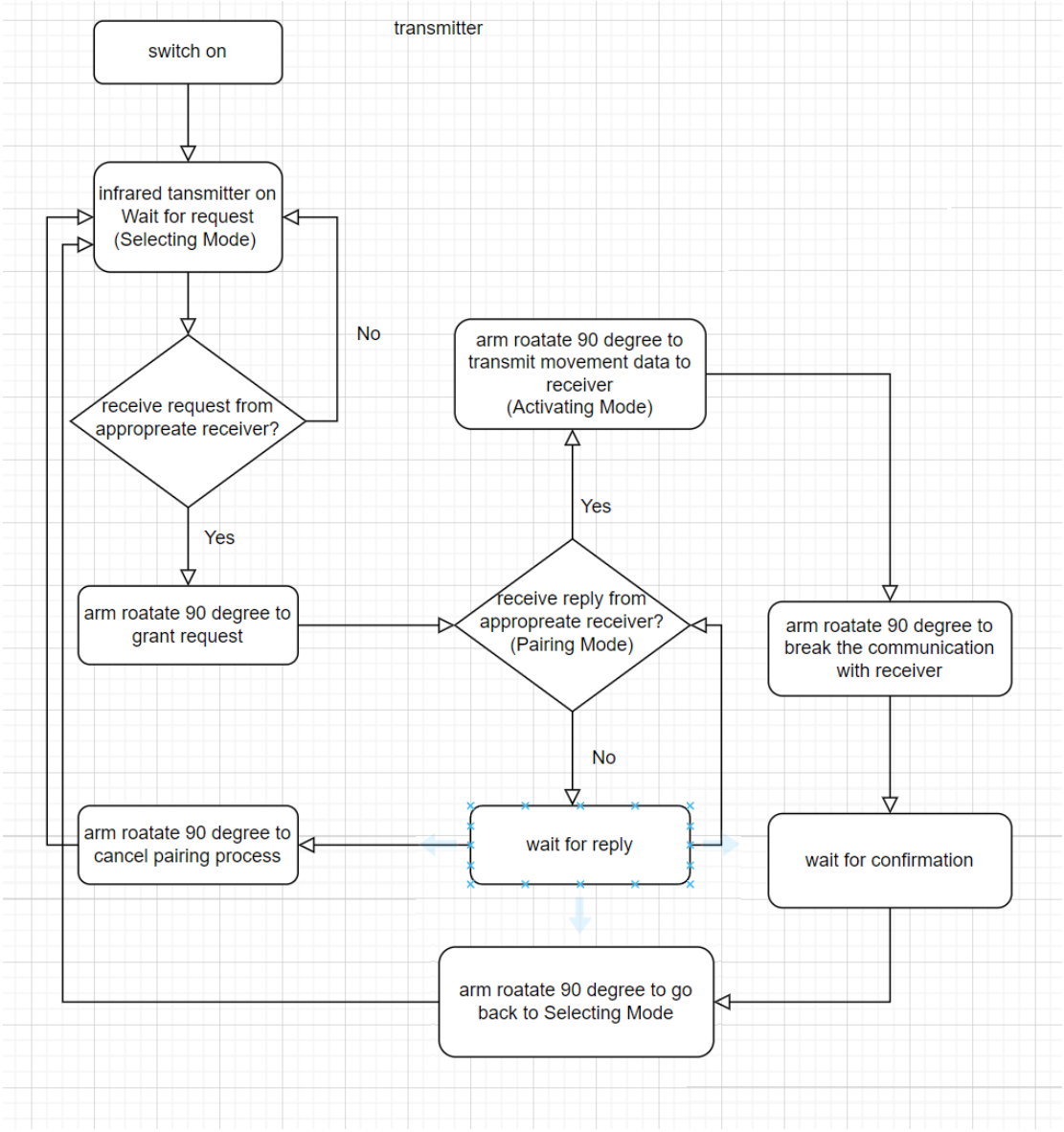


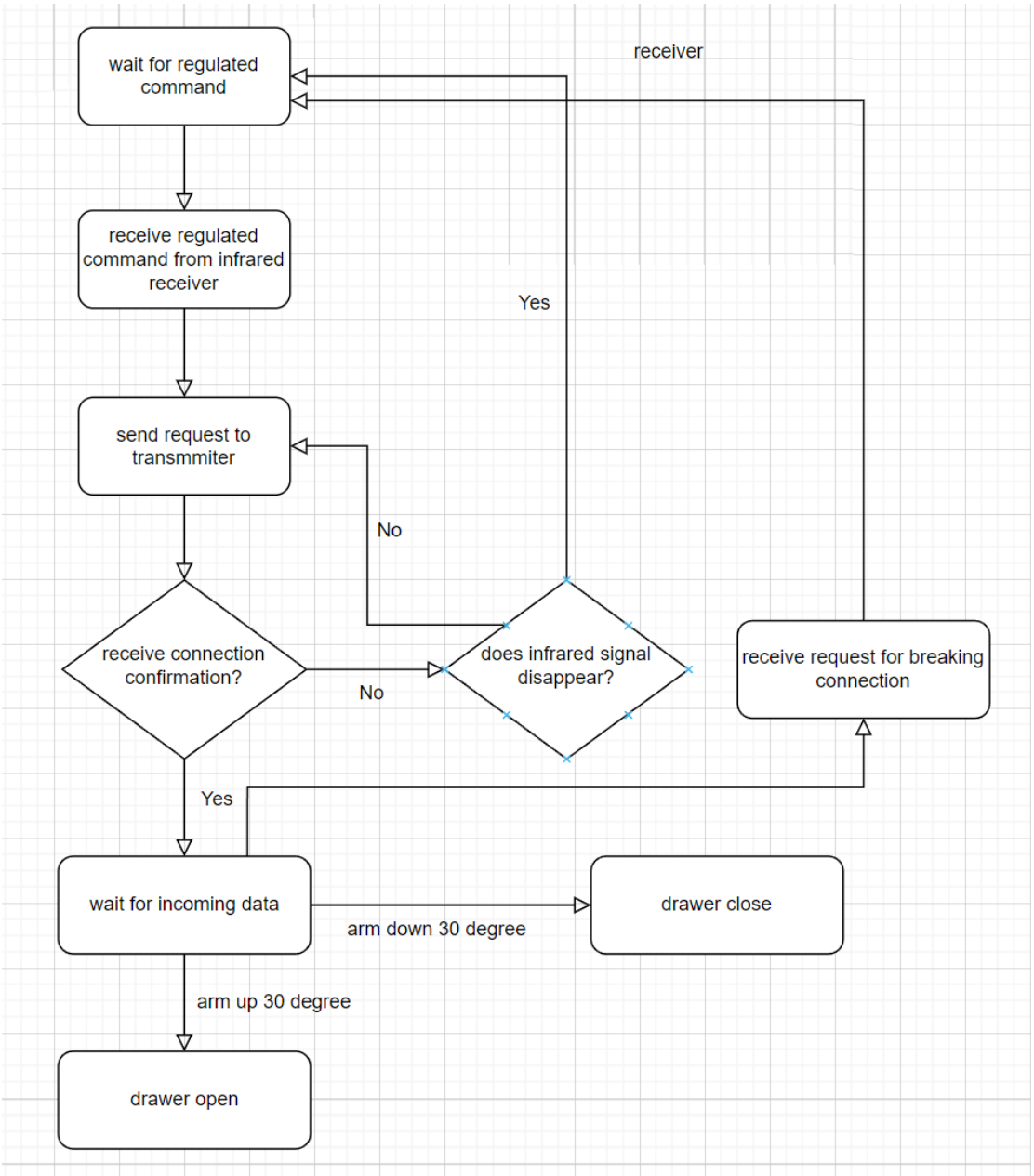
Basic design of system structure and workflow

5 Storyboard of the final user flow



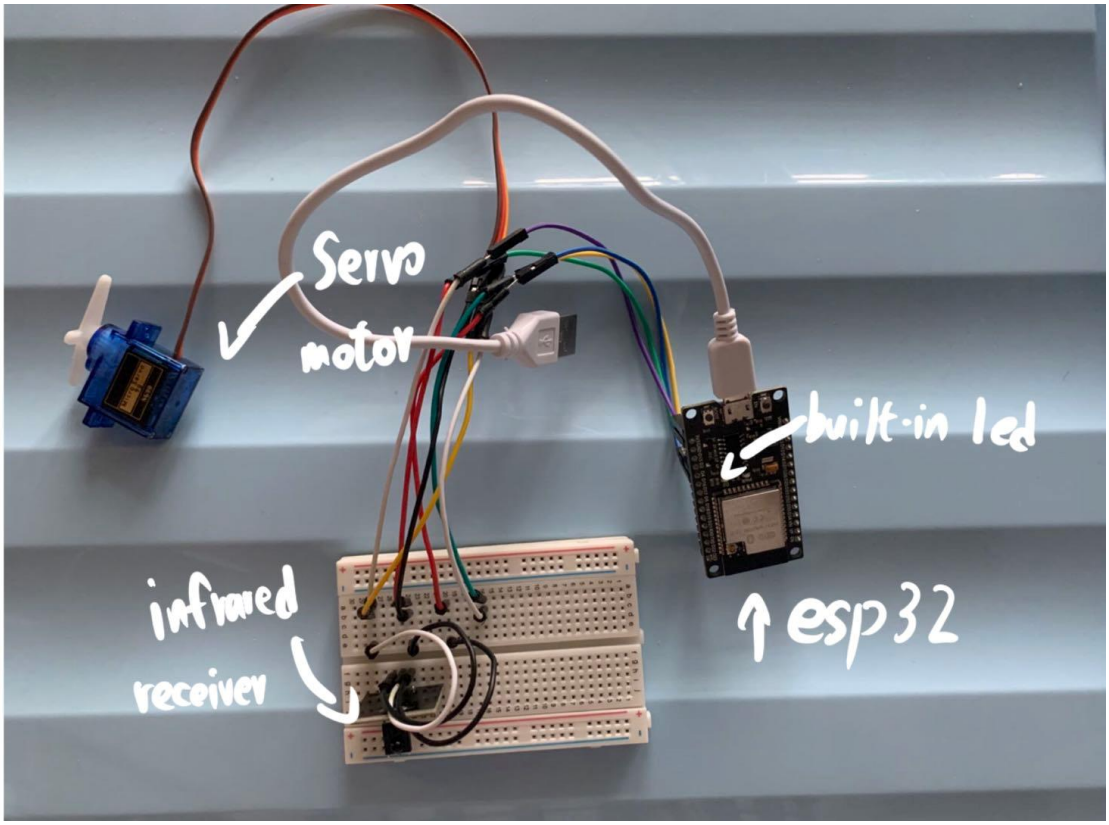
6 Workflow for transmitter and receiver



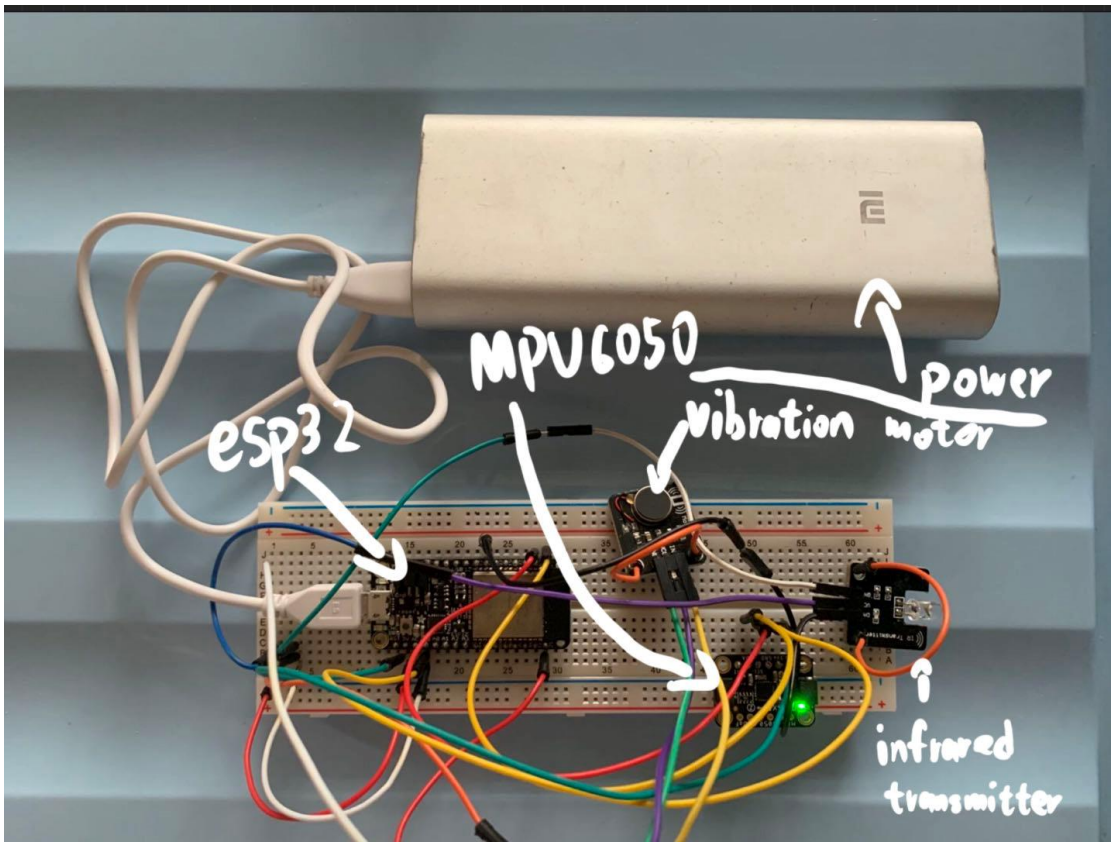

wait for regulated command
receiver
receive regulated command from infrared receiver
Yes
send request to transmmiter
No
receive connection confirmation?
No
does infrared signal disappear?
receive request for breaking connection
Yes
wait for incoming data
arm down 30 degree
drawer close
arm up 30 degree
drawer open

7 Annotated photos illustrating what you built (in your portfolio)

Receiver and control component



Transmitter component



8 Reflection about your design process and what you learned in this project

First of all, the teaching group provide us a very clear design life cycle from our first assignment. At the very beginning of our project, we should brainstorm all the possible element that could be involve in the topic which the project is about. After integrating the factors, developers should devise a challenge statement which can define the scope of ideation of this project, through analysis stakeholders, how they work with the defined issue, the limitation of the issue, we can come up with a statement in form of 'What if ____?', this is the basic ideation process for a project.

After I confirm what problem to solve, I started to do some background research to find out possible solution with effective and interesting interaction, all sources for background research are stored in form of picture, plain text and video link that make me convenient to browse again.

When I think there is a basic design in my mind through background research, the ideation would be started with sketching the prototype and initiate the basic work flow of the system. Then, the code work will begin. Several iterations are applied after there is a technical issue that can not be solved in short term, the work flow would be optimize to make it suitable to the iterative design. At last, the physical prototype would work properly as the work flow describe.

Through this project, I learn how to design and handle the life circle of a HCI project. Also, I learned a lot about Arduino programming and hardware design include how to write a driver for a hardware. Furthermore, I learned how to interact with sensors and convert the data in a desired form. To illustrate, in this project MPU6050 act as an important role in transmitter part, however, the initial data given by MPU sensor is meaningless number that cannot be used in actual environment, then trigonometric functions and machine learning algorithms are applied to transform data into useful form and achieve noise reduction. Learning theories and put them in practice is the most precious experience for this course,

9 A link to your video presentation

https://youtu.be/x95f8Vk8yEQ